REPORT

TRIPARTITE REVIEW OF REGIONAL PROJECT

FRUIT FLY CONTROL STRATEGIES IN THE SOUTH PACIFIC

(Project Nos: RAS/90/004 and RAS/90/A04)

Prepared by: A.J. Allwood, Chief Technical Adviser

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BACKGROUND

Project History

The first phase of the Regional Project on Fruit Fly Control Strategies in the South Pacific (RFFP) was initiated through a one-year project under the FAO Technical Cooperation Program (TCP/RAS/0055) in September, 1990. FAO provided US$174,000.00 for one year.

A second phase of the project (RAS/90/004) was approved in January, 1991 with joint funding from the United Nations Development Program (US$100,000.00), AIDAB (Australia) (indicative funding for the period of the project of US$295,000.00) and the South Pacific Commission (SPC) (US$36,000.00). Like the first phase, this phase focuses on developing environmentally sound fruit fly control strategies in the Cook Islands, Fiji, Tonga and Western Samoa to overcome quarantine restrictions on export of fresh fruits and fleshy vegetables. The project is due to terminate in September, 1993.

The project is being executed by SPC, with a sub-contractual arrangement with the Food and Agricultural Organisation of the United Nations (FAO).

FAO provides the services of a Chief Technical Adviser, who since September, 1991, has been funded by the AIDAB component of the Project. The Chief Technical Adviser manages the Project technically and administratively.

United Nations Volunteer Entomologists (UNV) were provided in Fiji, Cook Islands and Tonga initially for two years under the Japanese Trust Fund (SPF/89/V01). Funding of US$96,000.00 was provided for this purpose. In November, 1991, an additional UNV Entomologist was approved by the British Government for two years for Western Samoa. In August, 1992, the UNDP under its 5th Cycle funding, approved funding for the extension of the UNV's in the Cook Islands, Fiji and Tonga for a further 12 months (about US$60,000.00).

Description of the Sub-sector

In broad terms, the development policies of most Pacific Island countries aim to expand their economic bases, to further diversify their agricultural sectors, to strengthen and exploit export markets, to reduce their reliance on pesticide usage, to foster value-added processing and, at the same time, to become more self-sufficient in high quality, locally produced, nutritious horticultural commodities.

Fruit and vegetable production dovetails into the long term development plans of many Pacific Island countries. For example, a high priority objective in Fiji's development plans is to encourage export-led growth with emphasis on import substitution and self sufficiency of food production. As part of this objective, the development plan identifies encouragement of

diversification, which places particular emphasis on high value fruit, vegetable and spice export commodities.

Pacific Island countries are ideally suited to fresh fruit and vegetable production. They are relatively close to niche and major markets in Australia, New Zealand, Japan and the USA. There is also considerable potential for inter-country trade or import substitution between South Pacific Island countries, a concept often voiced by the Forum Secretariat. Other factors that demonstrate suitability of Pacific Island countries for fresh fruit and vegetable production include the high values of these commodities, relatively low labour costs, the requirements for small areas of land as a production unit, and the acceptability of fresh fruit and vegetable production as an integral part of subsistence agriculture and diversification.

Modest trade with Pacific rim countries has occurred in the past. For example, Australia imports US$1.2 m of fresh fruits and vegetables from Pacific Island countries; New Zealand imports US$9.3 m; and Japan imports US$1.5 m of squash from Tonga. In terms of international trade, these values are insignificant but, to small island countries with small populations and economic bases, these represent substantial contributions to their economies.

Unfortunately, Pacific Island countries have sizeable endemic fruit fly populations. Many of the fruit fly species are of economic importance to local production and their presence adversely affects access to export markets unless adequate preventative and disinfestation measures are available. This situation applies to the countries included in this project.

The access to export markets will worsen because of restrictions imposed by importing countries on the use of ethylene dibromide (EDB), thus resulting in the effective discontinuation of its use for disinfesting fresh fruits and vegetables likely to be infested with fruit flies. Australia, on 21 June, 1992, confirmed that the use of EDB on imported produce will be prohibited as of 1 January,1993. Likewise, the USA and Japan prohibit its use. New Zealand may, in time, follow this lead. Already, New Zealand has enacted legislation that restricts the permissable level of EDB residues in imported fruits and vegetables. This will take effect on 1 January, 1994. These actions will mean that, unless alternative treatments to EDB fumigation are developed, Pacific Island countries will not be able to gain access to any of these markets.

Further, without effective control of fruit flies during the production of some commodities, economic losses will continue to occur. Fruit flies can be controlled by using systemic insecticides as cover sprays, but these adversely affect beneficial insects (biological control agents and pollinating agents), result in unwanted residues in produce and may be environmentally unfriendly. A system of bait spraying using waste yeast products is being developed by the project; it provides an environmentally sound, cheap, non-residue forming method of control of fruit flies. Equipment used to apply bait sprays is

unsophisticated and fits into commercial and village production systems in developing countries. Also, if waste yeast from local breweries can be reformulated and used for fruit fly control purposes, pollution of waterways caused by disposal of this waste may be alleviated to some extent.

Pacific Island countries recognise the economic importance of the presence of damaging fruit flies to both production and export markets. With the assistance from the RFFP, countries are addressing this serious problem as part of their development objectives.

PROJECT GOAL, OBJECTIVES AND OUTPUTS

Developmental Goal

To increase the level of production and quality of fresh fruits and fleshy vegetables, leading to enhanced availability for local consumption, increased exports and higher farmer's incomes in the Cook Islands, Fiji, Tonga and Western Samoa.

Immediate Objective 1

To upgrade the technical knowledge and understanding of the impact of fruit flies on production and export of fresh fruits and fleshy vegetables by plant protection, quarantine, extension services staff and the private sector.

Outputs

1. Updated, valid information on the fruit fly species present in the 4 countries, their seasonal abundances, geographical distributions, host ranges, parasitoid prevalence, levels of parasitism, and stages of maturity at which fruits or vegetables become susceptible to fruit fly infestation.

2. Data on the levels of damage and, hence, clarification of the economic significance of fruit flies to production.

3. User friendly database on fruit flies using information from 1 and 2, to assist in quarantine decision-making by importing countries.

4. Government personnel and a private sector aware of, and trained in, fruit fly surveillance and assessment techniques.

Immediate Objective 2

To reduce the levels of damage to fresh fruits and fleshy vegetables caused by fruit flies.

Outputs

1. Development and adoption of cheap, environmentally sound, effective strategies for fruit fly control, based on bait sprays using yeast autolysate, either from local sources or from Australia.

2. Awareness by farmers of the benefits of good crop hygiene practices as an integral part of fruit fly control strategies and quality assurance schemes.

3. Government personnel and farmers trained in bait spray techniques.

Immediate Objective 3

To strengthen the capacity of quarantine services and the private sector to overcome quarantine restrictions on fresh fruits and fleshy vegetables imposed by importing countries.

Outputs

1. Advice on formulating quarantine protocols or procedures or host susceptibility testing, disinfestation treatments and quality assurance schemes.

2. Development and adoption of new post-harvest disinfestation treatments as alternatives to fumigation with ethylene dibromide, appropriate to the four project countries and acceptable to importing countries.

Common to these three Immediate Objectives is the provision of training of counterpart staff through on-the-job training, placement training, seminars, workshops and training courses. Also, awareness programs for farmers and exporters form an important component of project activities.

PROJECT ACHIEVEMENTS

Project Management

Equipment and Materials

The four project countries (Cook Islands, Fiji, Tonga, Western Samoa) have received adequate equipment and materials to undertake trapping, wild and commercial host surveys, rearing of flies from these samples, parasitoid rearing, bait spray testing, laboratory culturing of fruit flies and host status testing of fruits. The New Zealand Government provided the Cook Islands with a new fruit fly rearing laboratory where biological studies and post-harvest disinfestation research can be done. The RFFP has provided airconditioner units and constant temperature cabinets for Government-provided laboratories in Tonga, Fiji and Western Samoa

to assist with laboratory culturing of flies and biological studies.

The USAID funded Commercial Agricultural Development (CAD) Project will provide experimental equipment for development of quarantine treatments to Tonga and Fiji in November, 1992.

Expendable materials for trapping and host surveys have been provided to countries and replaced periodically, jointly by the RFFP and the ACIAR Regional Project on Identification and Control of Pest Fruit Flies in the South Pacific (ACIAR).

Staffing and Facilities

United Nations Volunteer Entomologists have been in place in Fiji, Tonga and Cook Islands since October-November, 1990 and in Western Samoa since December, 1991. UNDP under 5th Cycle funding has extended the UNV's in Fiji, Tonga and Cook Islands for a further 12 months. Together with support from counterpart staff, the UNV's have been instrumental in the many achievements of the RFFP.

The Governments in the project countries have attached counterpart staff to the RFFP and, consequently, with continued technical guidance, are capable of carrying out many of the project activities. Western Samoa and Fiji have allocated a graduate scientist and technicians; Tonga has committed experienced technical staff and provided project direction by a graduate counterpart. The Cook Islands has been able to provide technical staff only, but a graduate scientist will return in November, 1992 to play a major role in fruit fly work there.

A Project Assistant was appointed to the RFFP in Fiji in January, 1992 on a temporary basis for 6 months and finally for the period of the project in August, 1992. This delay was due to the requirement of SPC to obtain approval from CRGA and Conference for long-term appointment even though the position was externally funded.

Adequate laboratory facilities are now available in all project countries. The basic facilities were provided by the Governments, with modifications and improvements for the purpose of fruit fly work being provided jointly by the RFFP and ACIAR.

Financial Situation

In summary, 35% of funding from UNDP/UNDP IPF has been expended. The reason for the apparent low level of expenditure is that the quarantine treatment development (post-harvest disinfestation) has been delayed due to the USAID's CAD Project not providing equipment until November, 1992. This activity accounts for about 10% of the total budget. Also, the major effort in training, the Third International Training Course on Understanding and Managing Fruit Flies will take place after this review on 23 November-4 December, 1992. It and the Workplan Review account for 14% of funds.

Expenditure against the AIDAB component has been on target with 74% of funds provided by AIDAB up to July, 1992 being expended. There was a delay in AIDAB's funding for the period July, 1992 to September, 1993 due to Australian budget constraints. By the time of the review, this shortfall in funding may be resolved and adequate funds may be available though the total amount provided by AIDAB will be less than that expected.

Immediate objective 1

Trapping

In the Cook Islands, Fiji, Tonga and Western Samoa, permanent trapping stations have been established since April, 1991 under the RFFP. The location of stations on Rarotonga have been in place for 2 years, but were rationalised in early 1991. Trapping station locations in Tonga were also rationalised in 1991. All trapping stations in Western Samoa had to be re-established as they were destroyed due to Cyclone Val.

Each trapping station consists of two traps, one baited with Cue-lure and one baited with methyl eugenol.

Trapping stations are now located on the following islands:

. Fiji - Viti Levu, Vanua Levu, Taveuni, Ovalau, Rotuma (planned for September, 1992).

. Cook Islands - Rarotonga, Aitutaki, Mauke, Mitiaro, Atiu, Mangaia and Manihiki.

. Tonga - Tongatapu, Ha'apai, Vava'u, 'Eua and the Niua's.

. Western Samoa - Upolu, Savai'i and Manona.

These trapping stations form the basis of quarantine surveillance systems for major exotic fruit fly species. With exception of Ha'apai in Tonga, traps containing trimedlure used for surveillance for Medfly (Ceratitis capitata) are not included in the systems.

The trapping systems have provided data on the species of fruit flies present (Table 1), seasonal abundance, and geographical distribution (Table 1) and have confirmed the records of the fruit flies that are attracted to methyl eugenol and Cue-lure. Bactrocera xanthodes is attracted to methyl eugenol; Cue-lure attracts B. distincta, B. facialis, B. kirki, B. melanotus, B. obscura, and B. passiflorae. The other species listed in Table 1 are not attracted to either attractant.

Table 1: Geographical distribution and numbers of host records of fruit flies in the Cook Islands, Fiji, Tonga and Western Samoa from trapping records and host surveys in 1991-92.

	Number of Host Records			
Species	Cook Is	Fiji	Tonga	Western Samoa
B. aenigmatica	-	-	-	1
B. distincta	-	1	6	1
B. facialis	-	-	52	-
B. kirki	-	Rotuma In Traps	16	10
B. melanotus	32	-	-	-
B. obscura	-	Rotuma In Traps	Niua's only	1
B. passiflorae	-	41	Niua's only	-
B. samoae	-	-	-	?
B. sp. nov.	-	2	-	-
B. xanthodes	10	6	14	5
B. near xanthodes	-	-	-	1
Number of samples collected to July, 1992	2082	3317	1834	911

In general, most species occur in larger numbers in forest than that in commercial production areas. The highest peaks in numbers occur between November to May with smaller peaks in the May-July period. This obviously coincides with the fruiting periods of their major hosts. For example, in Fiji, B. passiflorae peaks coincide with the major fruiting period of guava (February-May) and Syzygium spp. Similarly, peaks in B. xanthodes coincide with the fruiting times of breadfruit.

This information has assisted project countries in negotiating with potential importing countries, quarantine protocols for fruit fly host produce. Together with the host fruit and vegetable surveys, these data have allowed countries to show that the major economic exotic fruit flies (e.g. Oriental fruit fly (B. dorsalis), Queensland fruit fly (B. tryoni), melon fly (B. cucurbitae)) do not occur in these countries. In the long term,

this information will assist in designing pre-harvest control strategies using bait sprays.

Broad Host Surveys

In the four countries, 8144 fruit and fleshy vegetable samples have been collected and held for emergence of fruit flies and parasitoids. Table 1 shows the numbers of samples collected within each country and the number of host records for each species. This work was done in conjunction with counterpart staff and with assistance from Australian workers in the ACIAR Project.

In Western Samoa, 7 species of fruit flies (Table 1) have been recorded, even though the number of samples collected has been relatively few due to the shortage of wild and commercial fruits caused by Cyclone Val's damage to vegetation and commercial crops. B. kirki and B. xanthodes are the most important economic species in Western Samoa. A new species similar to B. xanthodes has been recorded and hosts have recorded for B. aenigmatica and B. obscura for the first time. These new records demonstrate the thoroughness of the host surveys despite small numbers of samples.

In the Cook Islands, samples have been collected from Rarotonga, Aitutaki, Mauki, Mitiaro, Mangaia, Atiu and Manihiki. An extra 18 hosts for B. melanotus and 5 for B. xanthodes have been recorded since September, 1991, bringing the total number of hosts for B. melanotus to 32 and for B. xanthodes to 10. No other species of fruit flies have been recorded. In 7 hosts, both species occur at the same time.

In Tonga, samples have been collected from Tongatapu, Ha'apai, Vava'u, 'Eua and the Niua's. The concentrated effort on host surveys has resulted in the numbers of hosts for B. facialis increasing from 13 in September, 1991 to 52 in July, 1992. Similarly, the number of hosts for B. kirki has increased from 2 to 16, for B. xanthodes from 4 to 14 and for B. distincta from zero to 6 over the same period. The combination of host surveys and trapping has confirmed the occurrence of B. passiflorae and B. obscura on Niuatoputapu and Niuafo'ou. Of importance was the record of a melanistic (dark) form of B. facialis. Of importance to future post-harvest disinfestation research is the fact that 21 wild or commercial fruits and fleshy vegetables are able to host 2 or 3 species of fruit flies at the same time.

In Fiji, 3317 samples have been collected from Viti Levu, Vanua Levu, Taveuni, Ovalau, Mana Island, Nananu-i-Ra and Koro Island. B. passiflorae is by far the most important economic species with the numbers of host increasing from 37 to 41 hosts. B. xanthodes and B. distincta have been recorded from 6 hosts and one host respectively. B. distincta remains an enigma in that it occurs in sizeable numbers in traps throughout all islands but still has been recorded from one host only, namely sapodilla which is not widely distributed throughout Fiji.

One undescribed species has been recorded in Fiji from two wild hosts, Gnetum gnemon from Vanua Levu and Ochrosia oppositifolia on Viti Levu.

It is important to note that no fruit flies have been recorded from field collected fleshy vegetables such as eggplant, chilli, tomato, or cucurbits during the past 2 years.

As expected, the endemic species of fruit flies in each country has the largest number of hosts. B. melanotus, occurs in the Cook Islands only and has 32 hosts; B. passiflorae is endemic to Fiji and occurs in 41 host; and B. facialis occurs in Tonga only and has been recorded from 52 hosts.

Comment has to be made on the differences in the host ranges of B. xanthodes in the four countries. It seems that this species may be a complex of species, with B. xanthodes in the Cook Islands and Tonga having 10 and 14 hosts respectively, while B. xanthodes in Fiji and Western Samoa occurs in 6 and 5 hosts respectively. ACIAR has provided Dr. Drew of the Queensland Department of Primary Industries (QDPI) with funding to arrange DNA studies on this "complex" throughout the South Pacific.

Host surveys have provided countries with a much better appreciation of the species that occur, their host ranges and the economic significance of each species to production and export. It will also be possible to determine an index of damage caused by each species.

Intensive Host Surveys

This activity is aimed at providing data on the economic importance of fruit flies to production of fresh fruits and fleshy vegetables. Efforts concentrated on guava in Fiji (associated with a bait spray trial), capsicum and tomato in Tonga and mango and avocado in the Cook Islands. The level of damage (i.e. percentage of fruit infested under natural conditions) to guava by B. passiflorae in April, 1992 was around 37%. Damage levels to mango and avocado was less then 5% and 0.4-1.8% respectively. The level of damage to tomato and capsicum in Tonga was very low, probably due to the high use of insecticides on these crops. Specific crops with no insecticide use have been planted to ascertain the level of damage on untreated crops.

As was expected, the level of damage to most crops, except for guava, is low, probably less than 10% in most crops. However, it is still necessary to undertake pre-harvest control to reduce levels of damage to less than 1% to adhere to NZ quality assurance requirements.

Parasitoid Records

In Fiji, parasitoids are commonly reared from fruit collected between November to April but primarily in association with guava, kumquat, grapefruit, Inocarpus fagiferus, Ochrosia oppositifolia,

Syzygium spp and Terminalia spp. All of these are common hosts of B. passiflorae. Although parasitoids have been reared when B. passiflorae is associated with B. xanthodes in the same host sample, it is debatable as to whether parasitism of B. xanthodes occurs in the field. Under laboratory conditions, parasitoids will parasitise both species. It is not uncommon to record parasitism percentages of 10-15% from field collected material. Fiji are five species of parasitoids have been recorded from fruit flies in Fiji during this project. These are:

Aceratoneuromyia indica (f. Eulophidae)
? Tetrastichus sp. (f. Eulophidae)
Diachasmimorpha longicaudata (f. Braconidae)
Fopius arisanus (f. Braconidae)
Psyttalia fijiensis (f. Braconidae)

F. arisanus is the most common parasitoid being recovered from 10 host plants, while D. longicaudata was recovered from 7 host plants. Interestingly, D. hageni, an endemic species, has not been recovered during this project.

In Tonga, parasitoids are associated with fruit fly species reared from guava, Terminalia catappa, Surinam cherry, Malay apple, Calophyllum spp., Micromelum minutum and Ochrosia oppositifolia. Percentage parasitism is variable (1-83%). Although parasitism levels may be high on occasions, the natural level of parasitism is most likely to be around 10%. Work in Tonga has yielded a record of parasitoids from B. xanthodes. The species of parasitoids in Tonga are F. arisanus and P. fijiensis. One sample contained the pupal parasite, Spalangia sp. but this may be a contaminant.

In the Cook Islands and Western Samoa, the only species of parasitoid recovered was F. arisanus. Although D. longicaudata has been released in the Cook Islands in the past, surprisingly it has not established.

Database

The data from trapping and broad host surveys have been entered into a database held under the ACIAR Project with QDPI, Brisbane. Initially, Dbase III Plus software was used, but this has been converted to Rbase. Disk and hard copy will be provided to each country and the RFFP in November, 1992. In the interim, the RFFP has loaded all host collections from Fiji into a Microsoft Works database. An example page of the reports is attached as Annex 2.

Immediate Objective 2

Bait Spray Testing

No further work of the reformulation of locally available waste yeast from the breweries in the project countries has been done since the last tripartite review. The reason for this is that the ACIAR Project based in Brisbane is undertaking the reformulation research for the RFFP. Progress reports indicate that, by heating waste yeast from the Carlton Brewery in Brisbane various

temperatures between 35oC and 70oC for extended periods up to 20 hours and adding enzymes such as Tumicase and Papain attractancy to Queensland fruit fly is increased significantly. The aim of this experimental work is to rupture the yeast cells to release proteins on which the flies feed.

In the meantime, the four project countries have tested an Australian source of yeast autolysate to determine if the species of fruit flies in each country are attracted to this autolysate. All of the economic species in the Cook Islands, Fiji, Tonga and Western Samoa are attracted. This was tested by applying 50-100ml of a mixture of 100ml of yeast autolysate made up to 1 litre with water plus 4ml of 50% active constituent malathion to about one square metre of foliage on various fruit fly host trees. Dead flies were collected on calico sheets placed on the ground.

In Fiji, a field trial, designed to reduce fruit fly damage to a wild guava grove, showed that, by applying the bait spray weekly, it was possible to reduce the level of damage to guava fruit from 37% to zero in 4 weeks and to maintain the level of damage at 0-1% for 4 weeks. This result is so promising that it is planned to test the Australian bait on a commercial planting of 4000 mango trees at Nadi in October - December, 1992. Also, similar trials are planned for commercial citrus (oranges) at Batiri on Vanua Levu for May-July, 1993.

In the Cook Islands, field tests on the effect of the Australian bait spray on parasitoids and pollinating agents in guavas were carried out. No deleterious effects on either parasitoids or pollinating agents were recorded. Parasitism levels in treated plots remained at 44% during the trial.

In Tonga, plots of tomatoes, capsicums and zucchini have been planted at Vaini Research Station for testing the effectiveness of the bait spray system on reducing damage levels caused by fruit flies to these crops.

An important development in relation to the Australian yeast autolysate is that Burns Philp, the owners of the company that supplies the yeast autolysate, is interested in committing research staff to improving the attractancy of the autolysate in the hope of distributing the autolysate into the South Pacific and possibly South-East Asia. If the attractancy is improved, then it may be possible to use less of the autolysate, thus improving the economics of the baiting systems for growers in Pacific Island countries.

Farmers in Fiji, Cook Islands and Tonga are very keen to have this technology available to them as they see it as a necessary component of a quality assurance system which is a prerequisite for exporting fresh fruits and fleshy vegetables to New Zealand and elsewhere.

Immediate Objective 3

Laboratory Cultures

With the exception of Western Samoa, project countries now have viable laboratory colonies of the economically important species of fruit flies. The delay in Western Samoa has been unavoidable because of the paucity of host fruits caused by Cyclone Val. Therefore, it has not been possible to carry out large fruit collections to establish colonies. Hopefully, this will be rectified over the next few months.

In the Cook Islands, the colonies of B. melanotus and B. xanthodes have been taken over by counterpart staff and staff from the Horticulture and Food Research Institute (NZ) (HFRI).

In Tonga, laboratory colonies of B. passiflorae, B. kirki, B. xanthodes and B. distincta are established. B. xanthodes colonies are capable of producing 10,000 - 15,000 eggs per cage per week, and B. facialis 4000-5000 eggs per cage per week. Egg production of B. kirki has presented some problems; artificial egging devices are now being tested to try to overcome this problem.

In Fiji, laboratory colonies of B. passiflorae and B. xanthodes are very strong, capable of producing about 100,000 eggs per week. Artificial egging devices have been successfully introduced for B. passiflorae, with more development work required for B. xanthodes. The only research to be done for the laboratory colonies is to repeat an experiment to compare the locally developed artificial diet based on double diffused sugarcane bagasse/pawpaw/Torula yeast with three diets from the USDA-ARS Laboratories in Hawaii and the dehydrated carrot diet from Australia. This will be completed by mid-October, 1992.

Techniques for laboratory rearing of parasitoids have been successfully adapted from the USDA-ARS Laboratories in Hawaii and can now be used in any Pacific Island country, providing laboratory colonies of fruit flies are established.

Biological Studies

In the Cook Islands and Fiji, life cycle studies at various temperatures were completed in early 1992 and late 1991 respectively in preparation for post-harvest disinfestation research. Results for B. melanotus, B. xanthodes and B. passiflorae are being documented in scientific papers by Project and counterpart staff.

Mating behaviour studies in the Cook Islands, Tonga and Fiji have been necessary to ensure that the laboratory colonies are subjected to environmental conditions that are conducive to mating. It was found that B. facialis, B. passiflorae, B. distincta and B. xanthodes mate at dusk. B. kirki appears to mate at any time during the day, while B. melanotus mates in the morning.

Host Susceptibility Testing

The RFFP assisted the Ministry of Agriculture and Fisheries (MAF)(NZ) to develop a Standard for testing the host susceptibility of fresh fruits and vegetables to fruit flies. In Fiji, laboratory cage tests of pineapples (3 varieties), eggplant (3 varieties), chilli (2 varieties), bitter gourd, angle gourd, watermelon, pawpaw at colour break and for New Zealand, nectarines, apples and kiwi fruits have been done. The results so far indicate that the 3 varieties of pineapple will not host fruit flies and so can be exported to New Zealand without post-harvest treatment for fruit flies. If other commodities prove to be hosts under this cage test, then field cage tests will be done. Small plots of these crops have been planted at the Sigatoka Research Station for this purpose. The RFFP expects to complete most of these tests by the end of 1992.

In the Cook Islands, laboratory and field cage tests on cucumbers, tomatoes and zucchini are currently being conducted. Tests for New Zealand on kiwi fruit for B. xanthodes were also done, proving that it is a host.

Host susceptibility testing using laboratory cages were done in Tonga on nectarines, apples, kiwi fruit, zucchini, and horned melon. Apples and nectarines are hosts for B. facialis; results of the other tests will be available by 30 September, 1992.
Work on host susceptibility of bananas at various stages of maturity will be done in Western Samoa as soon as laboratory colonies are established.

Post-Harvest Disinfestation Treatment Development

At the previous Tripartite Review, it was stated that life history and heat tolerance studies would commence in August, 1991. The life history studies were completed in Fiji by November, 1991, but the heat tolerance studies of eggs and the 3 instars have not commenced. In the original project document, a sub-contract was supposed to be let to New Zealand, Australia or the USA to undertake this work. It was decided that, for the sake of sustainability of the project activities, it would be better if counterpart staff, with technical guidance from the UNV's and the CTA, carry out this work.

The most effective mechanism for carrying out this moderately technical component is to rely on experimental equipment and expertise from the USDA-ARS Laboratory in Hawaii. The USAID funded CAD-Project has now been approved and Fiji and Tonga will receive in November-December, 1992, experimental equipment including a transient hot water bath, a static hot water bath and in the case of Fiji, an experimental hot forced air unit. The research on heat tolerances of eggs and larval stages of the important species will commence in January, 1993 in Fiji and a little later in Tonga.

As Western Samoa has the similar economic species to those in Tonga, the research from Tonga will be directly applicable to Western Samoa.

The Cook Island program on disinfestation using hot forced air is the responsibility of the Cook Island Government and HFRI (NZ), although the UNV Entomologist with the RFFP has spent a considerable amount of his time assisting in this work.

The delays in commencing this work in Tonga, Fiji and Western Samoa is one of the major justifications for investigating possible funding sources for an extension to the Project. It is expected that the Project will be able to develop acceptable treatments for 1-2 commodities per year. To ensure confidence in generation of data and compilation of data in a form acceptable to potential importing countries, it is strongly recommended that data for 4-5 different commodities be developed over the next 3-4 years under the guidance of the RFFP.

TRAINING

Training has been viewed as a high priority by the RFFP, by Government staff and by the farmers and exporters in all project countries. Training has covered fruit fly identification, techniques for trapping, host fruit surveys, laboratory culturing of flies and parasitoids, bait sprays, and principles of pest risk assessment and quality assurance schemes for fruit flies.

The following training has been sponsored by the RFFP:

. In the Cook Islands, workshops were held for farmers and Ministry staff on Rarotonga, Aitutaki and Mauke in 1991 and on Atiu (12 staff, 21 growers), Mitiaro (15 growers) and Mangaia (11 staff) in 1992. (Also assisted by ACIAR funding).

. 3 staff form Mitiaro, Mangaia and Atiu were provided with additional placement training at the laboratory at Rarotonga.

. A Laboratory Assistant from Tonga attended two weeks training at the RFFP Laboratory in Fiji in December, 1991.

. In-country training of Tongan farmers (30), extension and quarantine staff (28) was provided in July, 1992.

. One day workshop on the biology of fruit flies and identification of adults and immature stages for 20 Fiji plant protection and quarantine staff, run by the RFFP and ACIAR.

. Since September, 1991, the RFFP provided training for 2 staff from Federated States of Micronesia, one Agricultural Officer from Solomons, one counterpart entomologist from Western Samoa, and a DSIR technical officer who went to the Cook Islands to take-over the laboratory culturing of flies. The training took the form of placement training in Fiji for 2-3 weeks each.

. Orientation training of 2 weeks for the UNV Entomologist from Western Samoa.

. On-the-job training of counterpart staff in Fiji (2), Tonga (4), Western Samoa (2) and Cook Islands (1).

. Farmers and exporters have been made aware of the RFFP and the results that have originated from the Project activities.

The major training activities for the Project is the Third International Training Course on Understanding and Managing Fruit Flies to be held at the School of Pure and Applied Science, University of the South Pacific on 23 November-4 December, 1992. It is jointly sponsored by the Crawford Fund for International Agricultural Research, QDPI and the RFFP. 25 participants from Fiji, Tonga, Western Samoa, Cook Islands, French Polynesia, Northern Mariana Islands, Tuvalu, Kiribati, New Caledonia, Solomons, PNG, Vanuatu, Federated States of Micronesia, Niue, and New Zealand will attend. Resource staff were selected from QDPI, RFFP, USDA-ARS Laboratories, Hilo Hawaii and the Media Centre of USP.

COMPLEMENTARITY WITH OTHER FRUIT FLY RESEARCH ACTIVITIES

Since September, 1990, the RFFP has acted as a central reference point for research and development on fruit flies in the South Pacific area, primarily to reduce duplication of effort and resources. Therefore, the RFFP provides essential linkages between other donor organisations and projects in this area of work, viz.

. ACIAR - Through the Queensland Department of Primary Industries, Brisbane, ACIAR is funding a three-year project on fruit flies in the Cook Islands, Fiji, Tonga and Western Samoa. The purpose of this project is to cooperate with the RFFP on taxonomic studies on fruit fly species in the four countries, to provide resource inputs into host fruit surveys, to develop and maintain a database on fruit flies for the Pacific countries, to provide high level technical assistance in developing effective pre-harvest control of fruit flies, and to assist with training.

. USAID - One of the components of the Commercial Agricultural Development (CAD) Project is designed to transfer various post-harvest treatment technologies to the South Pacific countries to replace ethylene dibromide fumigation as a treatment for fresh fruits and vegetables infested with fruit flies. Without very close cooperation between the CAD Project and the RFFP, the task of undertaking research specific to the fruit fly species and commodities in the South Pacific would require a significant redesign of both Projects. The major reasons for this is that the RFFP has done much of the ground work on establishing laboratory colonies of fruit flies and prerequisite biological studies on the damaging fruit fly species in each country. These two projects demonstrate the mutual benefit of open cooperation in achieving project objectives and hopefully, sustainability of activities within countries.

. Horticulture and Food Research Institute (NZ) (HFRI) - Close cooperation with the HFRI by the RFFP has ensured there is no duplication of effort in developing post-harvest treatments for some commodities in the Cook Islands. The RFFP has assisted with

resources for DSIR's effort in the Cook Islands and will be able to access data generated by DSIR and Cook Island counterparts.

. Ministry of Agriculture and Fisheries (NZ) - The RFFP has, with MAF (NZ), developed Standards for testing the susceptibility of fresh fruits and fleshy vegetables to fruit flies. The RFFP is now testing the procedure on pineapples, eggplants, chilli, bitter gourd, watermelon and some NZ fruits in the hope that post-harvest treatments may not be required for some horticultural commodities. The RFFP was able to provide technical inputs to the Bilateral Quarantine Agreement that was recently signed by the NZ and Fiji Governments. This may facilitate trade with NZ in fresh fruits and fleshy vegetables, providing adequate, acceptable fruit fly control mechanisms are in place.

. SPC - The RFFP is the focus for information and advice on fruit fly control strategies and the quarantine implications of the presence of fruit flies for countries in the South Pacific. Through SPC's training programs, the RFFP impacts on improving technical knowledge and capabilities of countries under the umbrella of SPC.

. Ministries of Agriculture (or equivalent) - The RFFP acts as a training resource for these Ministries. Staff from the Solomons, Fiji, Tonga, Western Samoa, Cook Islands, Federated States of Micronesia and Tuvalu have received hands-on training at the fruit fly laboratory in Fiji.

. Other Projects - The RFFP has been approached by AIDAB's Pacific Regional Team in Sydney to become involved in a proposed project on the rehabilitation of the fresh lime and juice industry in Niue. The input of the RFFP would be advice on fruit fly control strategies, with particular reference to host susceptibility testing of fresh lime at various stages of maturity. The expectation is to be able to export fresh limes without post-harvest disinfestation treatments.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The achievements of the project may be summarized as follows:

. Project countries now have increased capacity to carry out trapping programs, host surveys, parasitoid surveys, laboratory culturing of fruit flies and parasitoids, host susceptibility testing of commodities, testing of pre-harvest control techniques such as bait spraying, biological research using fruit flies as a tool, and assessments of damage caused by fruit flies.

. Technical knowledge on the fruit fly species present, on their host ranges, geographical distribution, seasonal abundance, parasitoid effects and levels of damage has been enhanced to a point where Governments should be more confident in negotiating quarantine protocols for export of fresh fruits and fleshy vegetables.

. Through close cooperation with ACIAR, a database on fruit flies in the South Pacific is in place, thus assisting in the quarantine decision-making process of exporting and importing countries.

. Initial results of testing of yeast autolysate as a component of the bait spraying technique have shown promise and, based on interest of farmers in this technique, the adoption of the technique will form an integral part of the quality control system that needs to be put in place for export produce.

. Laboratory colonies of fruit flies are now available and biological studies or rearing techniques, mating behaviour and life histories have been completed in preparation for post-harvest disinfestation research.

. Through effective cooperation with USAID's CAD Project, experimental equipment and expertise for post-harvest treatment development will be available or accessible from December, 1992 so a concerted effort on development of those treatment will commence in January, 1993.

. The program of training of Government personnel, farmers and exporters will ensure that a corps of trained technical staff and aware farmers and exporters will be available in each of the project countries.

Recommendations

The Governments of the project countries should maintain the inputs to the project by:

. progressively taking over the responsibility for continuation of the trapping and commercial host surveys programs already established as part of quarantine surveillance;

. assisting in wild host surveys to be done by ACIAR and RFFP;

. maintaining or, where necessary, upgrading laboratory colonies of economically important fruit fly species so that colonies are readily available and viable for post-harvest disinfestation research;

. assisting with and undertaking small scale and commercial testing of yeast autolysates as bait sprays for pre-harvest control of fruit flies, particularly in commodities to be exported.

. providing counterpart support for research into the development of alternative treatments to ethylene dibromide for disinfesting fruits and vegetables destined for export.

. continuing, with the assistance of the RFFP, liaison and cooperation with donor organisations funding fruit fly research in the South Pacific e.g. ACIAR, USAID, HFRI (NZ); and by

. supporting further training of staff, farmers and exporters to ensure that they are kept informed of new developments and technologies on fruit fly control.